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ABSTRACT

The use of the behavioral science principle of contingency in several approaches to teaching beginning reading is discussed in this paper. The failure to provide a contingent relationship between the given reading skill and student success in demonstrating the skill can lead to repeated apparent successes without the student actually manifesting the skill. Frequently, errorless progressions (shaping behavior) are used to establish heavily cued or prompted behavioral manifestations different from the desired terminal behavior; the cues are then gradually faded. Alternatively, a progression in complexity along the targeted behavior can be designed. Approaches to beginning reading differ principally in the nature of the progression used. The examples that are given indicate that progression in the target behavior is usually the most effective approach. Hence, basic research on errorless learning provides a framework for an informed judgment on the relative merits of different approaches to beginning reading. (Discussion that followed the presentation of the paper is included.) (Author/RL)

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Running Head: Analysis of Behavior in Reading Instruction

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Analysis of Behavior in Reading Instruction

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My aim in this paper is to illustrate the usefulness of the experimental analysis of behavior to the design of reading instruction. From the perspective of the analysis of behavior, all instruction, including instruction in reading, consists of arranging sequences of contingencies. Each contingency has three parts: (a) some material is presented to the student; (b) the student interacts with the material; and (c) the interaction has a consequence, frequently a reinforcing consequence. By concentrating on this deceptively simple concept of "contingency," I hope to demonstrate that its implications reach far beyond the "behavioral-copy-editing" level to providing a new basis for contrasting the modus operandi of several approaches to teaching initial reading.

When contingencies are effectively designed, the material presented is appropriate to the student's current level of achievement in the subject, the interaction is a behavior that takes the learner another step toward mastery, and the consequence reinforces the desired, newly emitted behavior. Instructional materials can fail to establish effective contingencies either by providing inappropriate cues that allow the correct answers to be achieved by trivial student behaviors, or by eliciting behaviors

only superficially related to mastery. Both problems can be illustrated in relation to reading instruction. I will begin with the first and probably the most common--inappropriate cueing.

Inappropriate Response Contingencies

Usually in an instructional situation only a small part of the student's activity is public and observable by the teacher--a question is answered about material the student has read, or an answer is written to a problem in the lesson material. The student's final public performance should depend upon the correct execution of the private act--a correct answer should indicate that the material has been read or the problem worked out. Over-cueing or inappropriate cueing enables the student to respond correctly without having actually performed the task that the lesson was intended to evoke. For example, when a teacher has students "read" aloud together, some children will respond on the basis of cues provided by other students rather than on the basis of the printed text. Such responses are "miscued." The importance of insuring appropriate response contingencies is often underestimated because of the apparent improbability of controlling a child's behavior by very subtle inappropriate cues. Psychology's famous "horse" story is an illustration of how, given proper training conditions, behavior can be controlled by inappropriate stimuli so subtle that even the source of the cues, the horse's trainer, was not aware of giving them.

Many students of general psychology are familiar with the story of Clever Hans, the remarkably intelligent Russian trotting horse, who had (in the hands of an extremely skillful teacher) demonstrated an ability to count, perform arithmetic problems, comprehend complex questions, spell, and even read (Pfungst, 1911). Unfortunately, Hans could not talk so he would manifest these skills by head shaking, and pointing, or by tapping out numerical answers with a hoof. In demonstrating his ability to read, a series of words (in German yet) were placed before him and he would point with his nose to the correct words. Hans's teacher, the remarkable Herr von Osten, used friendly encouragement and rewards in the form of bread or carrots. He worked entirely without aversive consequences--and this in 1904 while Skinner was but an infant in rural eastern Pennsylvania!

The first group of scientists evaluating Hans was quite taken in. A second group discovered that Hans could solve problems only with an informed audience. For example, if persons giving the question did not themselves know the answer, Hans was unable to solve it, and, in a more revealing instance, if the audience and Hans were given different questions, Hans answered the question put to the audience. Hans had learned to respond to subtle cues from the audience. To determine whether or not Hans could read correctly, the audience had to identify the position of the correct word and then watch Hans make his choice. In doing so, the audience gave Hans the cues he needed to get his carrots. Yet Herr von Osten himself

believed that he had trained Hans to perform on an intellectual level equal to normal thirteen- to fourteen-year-old children.

Indeed Herr von Osten had used a careful training sequence. On the targeted skills he began with an extremely simplified subject matter. For example, in teaching Hans to "read," he first taught Hans to indicate a single word, then one of a pair of words. He physically guided the earliest responses, then indicated them with gross physical motions and then more subtle signs. He was always ready with carrots and bread at the instant that his student followed his lead. Two progressions were present in this training procedure--the targeted tasks increased in complexity and, at the same time, the extraneous cue of physical guidance, jestering, etc., decreased gradually until the trainer himself was unaware that he was still providing cues. Unfortunately, the targeted cue, the text itself, never gained control. The fading stimuli, which were not completely removed until the revealing experiments were performed, continued to control.

The lesson of Clever Hans has been difficult to learn. At the 1975 APA convention an experiment was described in which a severely retarded girl was taught a sight vocabulary of 54 words or phrases (Rosenbaum & Breiling, Note 1). The reading material appeared on individual cue cards and included such phrases as "point to the car" or "point to the man smiling." The girl responded by pointing to one of several pictures on cards laid out on the table before her. During training, if she was correct she was praised and given

candy. If incorrect, the experimenter read the instruction aloud himself and modeled the behavior for the subject. After a pause the card was presented again and the student prompted to do what the card said. If necessary the subject was physically guided through the behavior. Learning appeared to be amazingly rapid--after only eight 15-20 minute training sessions the severely retarded subject was close to 100% correct.

The experimenters were mainly interested in identifying what reinforcing aspects of the situation were important. Candy was first eliminated and various attempts made to obscure the face of the experimenter. But none of these efforts had more than a minor disruptive effect on performance until a projector was used to present the cues and the experimenter left the room to observe through a one-way mirror. Performance then disintegrated to between 10% and 35% correct on various sessions. It seems to me that the ghost of Clever Hans haunts this experiment.

When both Clever Hans and a severely retarded child can convince people especially attuned to the misuse of cues that they are "reading," can we possibly be surprised by the wholesale failure in maintaining appropriate response contingencies in the traditional classroom? John Holt, a leading author in the educational protest literature, provides many examples from classrooms of children using inappropriate cues--cues which circumvent the to-be-learned skill. In one instance, he describes a classroom in which the teacher was performing a drill on the blackboard designed to teach the identification

of nouns, adjectives, and verbs. She arranged three columns on the blackboard, one for each category, and as she said each word she asked a child in which column it belonged. As Holt describes it:

> the percentage of hits was remarkably high, especially since it was clear to me from the way the children were talking and acting that they hadn't a notion of what Nouns, Adjectives, and Verbs were. Finally one child said, "Miss _____, you shouldn't point to the answer each time." The teacher was surprised, and asked what she meant. The child said, "Well, you don't exactly point, but you kind of stand next to the answer." This was no clearer, since the teacher had been standing still. But after a while, as the class went on, I thought I saw what the girl meant. Since the teacher wrote each word down in its proper column, she was, in a way, getting herself ready to write, pointing herself at the place where she would soon be writing. From the angle of her body to the blackboard the children picked up a subtle clue to the correct answer (Holt, 1964, p. 15).

As though this were not sufficient, this teacher kept the three columns approximately equal in length. Thus, the first word after the columns came into balance might be a blind guess, but for the next there would be one chance in two to get it right, and for the final word the correct column was a dead give away.

Holt describes many such failures to assure a contingent relation between correct performance and actual mastery in the classroom. It seems likely that most of us can think of a host of examples from our own experience. The new educational technology should help the teacher who is, frankly, faced with an almost impossible task. Indeed it does help, but even with technology and with theory-inspired design, there are problems of inappropriate contingencies.

O. K. Moore's Talking Typewriter. One technologically based effort in reading instruction received considerable popular attention in the 1960's, spurred by a film report showing a few children learning to read using a "Talking Typewriter" (Moore & Anderson, 1960). In the film, O. K. Moore's daughter and a few other children, under careful adult guidance, use an electric typewriter. Early in training as the child strikes a key the adult says its letter name. Later the adult approximates the phonic sound as a key is struck. Next a projector presents letters and the child matches the letter by striking the appropriate key. The adult operates a hand switch to cut off the power should the child begin to strike an inappropriate key. When the appropriate key is struck the adult pronounces the phoneme. Later the projector presents whole words and still later, sentences. The adult continues to use the hand switch to cut off power before inappropriate keys are struck and to pronounce the individual phonemes and the completed word. The entertaining filmed report gives the impression of well-designed contingencies in a progression of tasks that result in reading.

Unfortunately, the film is not sufficiently detailed to permit one to ascertain precisely what elements of the described procedures are effective or whether there are other, perhaps unrecognized, roles played by the adult. When the "talking typewriter" was fully automated, it became possible to examine carefully the effects of the procedures and contingencies. Automated equipment, prepared by Edison Responsive Environment, produces letter names or appropriate phonemes automatically as a key is struck. When the child is to match a projected letter, inappropriate keys are locked permitting only the designated key to operate. Richardson and McSweeney (1970) then set about the task of experimentally evaluating the "talking typewriter" procedures, and found the results most unimpressive. In analyzing the failure of these procedures, Richardson and McSweeney noted that in the initial free exploration days when a press on any key produces the appropriate sound, there is, in fact, absolutely no contingent relationship between the keyboard letter and the spoken sound so far as the child is concerned. The child does not need to look at the letter nor attend to the produced sound, even though this phase is supposed to teach letter-sound associations. Thus, many children fail to learn these associations.

In the later phase, when the child is shown words or letters, and is to type corresponding letters, the automated keyboard locks all incorrect letters. The child need merely hunt among the keys to find the unlocked one and, in time, type a perfect message without attending to the visual display, the

letters on the keys, or the sounds produced in striking the keys. If a child has completed the first phase without learning letter-sound associations, it is especially likely that he or she will continue to perform in this non-reading way. And that child will continue to succeed! Nothing in this "advanced" phase assures that the child will attend to any grapheme-phoneme association. Clever Hans lives in the age of technology.

Teaching Early Reading "Errorlessly"

Thus far I have focused on problems in assuring appropriate response contingencies. Yet one could design items whose correct solution indicated appropriate learner behavior, but which the intended learners simply could not solve. Although such items assure appropriate response contingencies for correct answers, they are inadequate as teaching items. Good materials insure that the children can successfully perform the behaviors called for by devising a careful progression in task complexity.

To devise appropriate progressions in task complexity, we must undertake a behavioral analysis of the to-be-learned task and of the entry behavior of the learner. As a first step, reading might be analyzed as follows. Competent readers recognize a large number of words, and have vocal or subvocal behaviors under control of whole words or phrases such that their rate of reading is far too fast for single graphemes and phonemes to be functionally serving as stimuli. In contrast, non-reading children may have substantial speaking and listening vocabulary but they do not yet have these responses under control

of textual stimuli. Children learning to read are confronted, then, with clusters of visual forms that are highly similar to one another. Yet these almost identical forms were arranged by the writer in response to the sequence of sounds in which the individual units or characters are controlled by a corresponding sound. For skilled readers, the resulting sequence controls their vocal (or subvocal) behavior so that they will say the word or phrase that the writer said. When confronting an unfamiliar cluster of characters, the reader can fall back on responding to a smaller unit than the total word by emitting the sounds controlled by groups of syllables or, on rare occasions, even by the individual graphemes. This skill (responding to a new combination of letter forms to produce the sounds similar to those produced by the author) is so uniformly developed throughout the literate population that a single author may generate a completely new word and have it quickly become a part of everyone's reading vocabulary. Consider, for example, the word snafu.

And "snafu" might be the response of the hep English-speaking child on first discovering that many identical printed letter forms, in the context of other letters, must control different sounds (such as long and short vowels) and that many different letter forms control the same sounds (c or k for /k/). The reading teacher, then, has the task of getting the nonreader both to read a large number of words without resorting to smaller unit decoding and to decipher new words despite the lack of a simple phoneme-grapheme correspondence in English. The early

tasks must be manageable by the child and, at the same time, must progress toward the targeted behavior of the proficient reader. The hotly debated issues among look-say, phonics, and linguistic approaches are fundamentally debates on what form of early steps are both manageable by the child and useful in progressing toward proficient reading. I propose at this point to describe some basic findings from the experimental analysis of behavior which bear on these issues with the hope of suggesting a theoretical rationale useful both in deciding among approaches and in sharpening the execution of particular approaches. The first illustration of the usefulness of basic research findings in the design of reading instruction involves a relatively minor matter in sequencing.

Why begin with the alphabet? Chall (1967) concludes that teaching either letter names or phonic values is necessary before beginning reading instruction. The basic operant literature provides a rationale for the usefulness of early alphabet training in one of the best known and most fundamental findings, the phenomenon of stimulus generalization. In the typical demonstration, a given point on a stimulus dimension (for example, a particular wavelength of light) is the occasion on which a response will be intermittently reinforced and, as a consequence, future presentations of that wavelength result in responding. During a later test phase, other points along the stimulus dimension are presented. These too will result in some responding. For example, if the test color is fairly close in the spectrum to the orginal trained color, it will evoke almost as

much responding as the original stimulus. The frequency of responding decreases with the distance from the trained stimulus, but a sizable amount of responding is evoked by stimuli that are a considerable distance away. More precise differentiation of the stimulus dimension results when responding to one stimulus is reinforced while responses to other stimuli even quite close to it are unreinforced, or when each stimulus is trained to a particular response (Nevin, 1973).

Letter forms are quite similar to one another. In fact, we might say "all letter forms look alike to us" until we have become personally acquainted, for example, by being on a first-name basis with them. Until some diffential response such as the letter name is learned, the child would be expected to show stimulus generalization for letter forms by responding to different letters as though they are the same. Although critics of teaching letter naming are correct in contending that the act of naming letters is not actually a part of reading, differentially responding to letter shapes is a basic part of mature reading.

"Errorless" learning research and a comparison of three early reading techniques. The basic operant literature also has something to contribute by way of rationale concerning some contrasting approaches to providing a suitable series of learning tasks that introduce the novice to reading. Skinner's earliest work emphasized the gradual shaping of a new skill and, hence, what has been called "errorless learning." Reading curriculum approaches have always had some form of progression; to have started with the complete reading task of the mature reader

would be folly. But what is asked of the beginner and how do the early tasks relate to later proficiencies? These are the issues which divide contesting approaches and to these issues, I believe, recent basic research on errorless learning relates. This research has been attempting to determine the conditions necessary for attaining new discriminative control errorlessly (Sidman & Stoddard, 1967; Terrace, 1963; Touchette, 1968). Errorless sequences are usually successful when the progression is from a prominent stimulus to a more subtle stimulus along the same dimension. In fact, a simple gradual progression on the same stimulus dimension can easily carry control to the limit of sensory capacity. For example, Clever Hans's trainer prominently signalled the correct response with gross gestures early in training and later, unknown to the trainer, maintained very subtle physical signalling.

A problem arises when there is no means of establishing initial control on the relevant stimulus dimension. A common solution involves pairing the target stimulus with an irrelevant, but highly prominent, stimulus which can initially control the response. In Clever Hans's case, the physical gesturing cues were supposed to be faded out until Hans was under exclusive control of textual stimuli. As we have seen, when the fading stimuli were indeed completely removed it was shown that textual stimuli had never gained control. This fading cue technique, common in the laboratory and instructional design, is frequently called a "transfer of stimulus control." Unfortunately, the technique is unpredictable--sometimes it

works, other times does not. Instructional designers often find that developing a successful fading series involves a tedious trial and error procedure. Occasionally, when formative evaluation of instructional design is weak or absent, an unsuccessful fading series may survive to haunt users of the finished curriculum materials. Basic research on fading cues recently completed at the Learning Research and Development Center by Judith Doran (1975) offers designers some guidelines for developing successful fading series, and also offers a rationale for choosing among several techniques of beginning reading instruction.

Doran (1975) reasoned that during a fading sequence, the fading stimulus and the target stimulus comprise a compound stimulus similar to the situations often studied in selective attention. Initially, only the fading stimulus controls the response. She argues that the criterion stimulus will gain control at the end of training only if it begins to share control with the fading stimulus sometime during the fading sequence. This shared control should happen consistently only when the target stimulus itself is sufficiently prominent that the subject can begin to use it early in the fading series. If both cues do not share control well before the fading stimulus has been completely removed, the sequence will essentially train finer and finer discriminations of the irrelevant cue stimulus.

In Doran's experiment, children acquired a size discrimination for circles projected successively on a single transilluminated key (see Figure 1). The positive stimulus (S^+) was always

a brightly,illuminated 14 mm diameter circle. The child responded

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Insert Figure 1 about here

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by pressing the illuminated key. On S^+ trials, responding was intermittently reinforced.

The negative stimulus (S^-) was a smaller circle. On S^- trials, responding was never reinforced. During training, a fading stimulus or irrelevant cue was superimposed on the S^- circle. In this instance, the fading series began with S^- as a completely dark key to which children did not respond, and gradually over a series of trials, the S^- was brought up to full brightness. Thus, the prominent irrelevant cue was brightness, and the target discrimination was circle size.

There were three different problem difficulties involving three negative stimuli (S^-) of different sizes. In all problems the S^+ was a 14 mm diameter circle. In problem A, the simplest problem, the S^- circle diameter was 5 mm, easily discriminable from S^+. In the intermediate problem B the S^- circle diameter was 10 mm, and in the difficult problem C, 12 mm. Since S^+ and S^- were never present simultaneously, a 2 mm difference in diameter was a very difficult discrimination.

After each block of ten trials, two probe stimuli were used to identify which element of the compound stimulus controlled responding (Fig. 1). One probe was the current S^- circle size, but at full brightness; the companion probe was the S^+ circle size, but at the brightness appropriate to that

point in the S^- fading series. If the subject responded to the smaller, fully bright circle, but not to the large, dimmer circle, responding was controlled by the irrelevant fading cue, brightness, alone. If the subject did not respond to either probe, dual control was indicated since neither size nor brightness alone was sufficient to evoke a response. Responding to the large, dimmer circle but not to the small, bright circle indicated control by size alone. Finally, if the subject responded to both probes, neither stimulus was controlling the response, a condition which ordinarily prevailed when the subject was responding to all S^-'s in training as well.

Figure 2 shows data for five subjects on the most difficult

Insert Figure 2 about here

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of the size discriminations (Problem C) on four successive daily sessions (C_1 through C_4). The data are shown as individual records for each of the children in each of the sessions. They are plots of trials on which errors occurred. The horizontal lines in the first three or four blocks of trials indicate that performance was totally error free. The stairstep effect in the final blocks indicates that as the brightness cue became too difficult and finally impossible to use, errors occurred in the form of responding to the S^-. Typically, in the early trials consistent control by brightness is indicated by the first, second, and third probes, followed by control by neither for the fourth and fifth probes. In the final and criterion phase,

without a brightness cue, there are extensive errors.

The conditions represented here are analogous to those seen in curriculum materials in which a prominent irrelevant cue is used to assure initial correct responding, and the irrelevant cue then gradually faded out. When there is no contingent relationship for attending to the target dimension and little likelihood that it will enter into a controlling relationship because of its relative lack of prominence, the fading sequence will frequently fail to assure the desired final performance.

In the second condition in Doran's study, children first learned the easiest of the three discriminations (Problem A), then the intermediate one (Problem B) and finally the most difficult (Problem C). This sequence involved a progression on the relevant target dimesion, circle size, from easiest Problem A to the difficult Problem C. In each individual problem, however, the brightness fading series illustrated in Figure 1 was used. It is apparent from the data presented in Figure 3

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Insert Figure 3 about here

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that these five subjects collectively made very few errors in learning, and only one of the subjects, Ara, showed any errors in the criterion phase of the difficult problem. Typically, before the criterion phase of each problem was presented, probes indicated either control by size or, more often, dual control by size and brightness.

Because of the striking difference in size between S^+ and S^- in Problem A, brightness fading was successful. Having gotten size to control responding in one problem, it was easy to establish it in successively more difficult problems. Apparently, then, a progression on the target dimension maintains attention to the relevant stimulus and assures success. Relying on fading an irrelevant cue dimension is a questionable practice which, when it must be used, should be paired with a particularly salient targeted stimulus which can then further progress toward an increasingly subtle criterion discrimination.

Stepping Stones to Reading. As I indicated earlier, approaches to establishing a useful progression in the teaching of reading differ in ways relevant to the Doran study. The unique feature in a reading curriculum prepared at the Learning Research and Development Center called Stepping Stones to Reading (Kjeldergaard, Glaser, and Frankenstein, 1973) is its use of color to code the various graphemes. A given color is associated with a single phoneme even though the phoneme is represented by various graphemes. For example, purple was used for the /i/ sound in high, kite, and fly. Moreover, when a given letter form is associated with different phonemes, the color coding functions to distinguish them. For example, in kite, kit, and fir, the letter "i" would be printed in purple, red, or dark green respectively. A total of 11 colors were used, but vocabulary was choosen so that no page had more than five colors. Here then is a reading program that has as its major feature the use of quite prominent fading stimuli irrelevant to the targeted stimuli of letter-form

discriminations, spelling patterns, and context. Findings from the Doran study would predict some difficulty with this approach.

An experimental evaluation of Stepping Stones to Reading was carried out by Helen Popp (1972) and some of her results I find compatible with the suggestion that this fading technique might be ineffective. Her study not only evaluated the standard version of the program, but had another group use a "reduced color version" which dropped the color coding more quickly. The version which dropped the color coding more quickly gave superior posttest results. This superiority of the faster fading held as well for a "low readiness" group that the investigator had thought might need the most color prompting. They did not, possibly because the color prompting was not helping. It is unfortunate that no version was tried that had no color coding. We cannot conclude from this study that color coding was no help at all, but the basic data from Doran's study raises this suspicion and there is no evidence to dispell it.

Modified alphabet. Another way to attain consistent correspondence between graphemes and phonemes in early reading is to modify the alphabet so that the printed forms are in a (more or less) one-to-one relationship with English phonemes. Diacritical markings are among the most common and least extreme of these modifications, but one which has caught most attention has been Sir James Pitman's Initial Teaching Alphabet (ITA) consisting of 44 characters, each having a single phonemic value.

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Insert Figure 4 about here

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In the beginning stage of reading instruction all materials are printed in the ITA characters illustrated in Figure 4. Later, after the children master reading this alphabet, they switch to the standard alphabet.

To translate this into the language of the Doran experiment, the ITA is a set of initially controlling stimuli ("fading stimuli") and the standard alphabet forms are "target stimuli." Unlike the color-coding approach, the ITA bears some relevance to the targeted standard alphabet. First, the characters of the standard alphabet also are included in the ITA, although there they represent only one phoneme. Many of the new forms created for the ITA also bear a reasonable resemblance to the standard forms which must eventually control the child's responding, although other ITA forms are quite different.

Since the child does start reading in ITA by discriminating forms, some of which are close approximations to the standard alphabet, the ITA approach should be less subject to problems of fading on an irrelevant dimension than a color-coding method. However, ITA does not seem to be an ideal fading series even so.

Here, as with experiments on the color-coding approach, one might wish for more help from the evaluation data, but unfortunately, here too the data are not sufficient to settle the point. Downing (1964a, 1964b) has shown that ITA is more easily learned than the standard alphabet, and has also reported better word recognition a half-year after transfer to the standard alphabet for

ITA children than for children trained initially on the standard alphabet. However, Chall (1967) identifies some problems with these data, such as omitting to report the makeup of the classes or to mention controlling for time spent in reading instruction. Most significantly, she points out that the ITA group started phonics work "a good deal earlier" than controls. She concludes:

> So far, the experimental evidence is still too limited to allow definite conclusions about the long-term advantages (and disadvantages) of using a modified alphabet. That ITA has its share of failures we know from a paper [of] Sir James Pitman. . . . We also can infer some lack of success from Downing's report (1964b) revealing that after two years, 15 percent of ITA-trained children had not yet been transferred to [standard alphabet] (Chall, 1967, p. 124).

This hint of difficulty in switching to a standard alphabet is suggestive of a deficiency in the "fading series."

Bloomfield's linguistic approach. One early reading approach is exemplary in using a progression on a relevant dimension and thus in having the child perform from the beginning in terms of the stimuli that are to control final skilled performance. Bloomfield and Barnhart's (1961) Let's Read is an alphabetic approach to English. Bloomfield analyzes reading as "producing the phonemes of one's language when one sees written marks which conventionally represent these phonemes" (Bloomfield &

Barnhart, 1961, p. 26). But early phoneme-grapheme correspondence is not taught by segmenting and subsequently synthesizing phonemes in what has been called the systematic phonics approach. Instead, only whole words are used from the very beginning. The progression in task complexity is from short words with completely regular spellings in which each letter has only one phonemic value (i.e., get, got, gun, but not gem) to more complex reading tasks, with the complexities grouped according to their spelling characteristics. Only in part four of the five-part program are many irregularities introduced. By this time the child is a veteran at handling the code.

A potential difficulty in the Bloomfield's linguistic approach is that it is apparently difficult to get children to induce the sound values of letters. Nearly everyone who has modeled a reading program on Bloomfield has introduced some form of single-letter sound analysis. Given this additional prompting, the Bloomfield system seems to be an outstanding example of progression which maintains the desired behavior thoughout.

The direct experimental data available on Bloomfield's approach is in the form of a comparison of a linguistic program (Let's Read), a modified linguistic program (Structural Reading Series) and a basal reader (Ginn Basic Reading Series) by Sheldon, Nichols and Lashinger (Note 2). While all three programs taught well and the differences in test results were minimal, the linguistic approach did yield better performance on the Gilmore Oral Reading Test, and the linguistic and modified linguistic groups were better than the basal in the Stanford Test subtests on word

meaning and spelling. Unfortunately, experiments which would directly show the effect of progression along relevant target behaviors in the context of reading programs have yet to be done.

Summary

A simple basic concept from the experimental analysis of behavior--the concept of contingency--has been shown to have important implications for classroom teaching practices, curriculum development, and for the highly instrumented products of educational technology. For each, the failure to provide a contingent relationship between the given reading skill and student success in performing the exercise can lead to repeated apparent success without the student performing the skill at all.

Frequently, errorless progressions first establish heavily cued or prompted behaviors that are different in kind from the desired terminal behavior. The cues or prompts are then gradually faded. Alternatively, a progression in complexity along the targeted behavior can be designed. Approaches to initial reading differ principally in the nature of the progression used. The color coding of different sounds is an extreme example of fading on an irrelevant dimension, the Bloomfield linguistic approach a clear example of using almost exclusively the target behavior. The modified alphabet approach is intermediate between these. Basic research on errorless learning indicates that progression in the target behavior is usually the most effective approach. Hence, the basic research on erroless learning provides a framework for an informed judgment on the relative merits of the several approaches to beginning reading, and guidance for future development of initial reading material.

That the atheoretical, descriptive approach of the science of behavior should see easy application to reading instruction is hardly surprising. Skinner (1954) long ago called attention to the implications of an experimental analysis of behavior for educational practice. With this approach basic work leads naturally to application in practice, and experience in practice leads equally naturally to basic analytic research. Indeed, I have shown elsewhere (Holland, 1976) that basic work in errorless discrimination learning received its first impetus from common practice in the early days of programmed instruction.

The ease of application of the experimental analysis of behavior contrasts markedly with the generally meager practical yield of theory-oriented research. This contrast is a direct result of the difference in objectives and methods of the two types of research. Theory, as the term is used here, is an explanation of observed events by events on a different level of analysis. Commonly, errors or latency of responses are the data explained by theories involving physiological or mental events. These theoretical entities typically are the principal object of study for the theorist. Thus cognitive theorists might be studying "memory stores" and the "accessing of memory". To do this they may measure latencies in reading words as an indirect index of the non-behavioral entity which is the object of study. A systematic understanding of reading or even of latencies in reading words, is not the direct object of the research. Application, if it is to ever occur, must await the eventual completion and verification of the theory.

In contrast, the analysis of behavior determines controlling relationships on the behavioral level. The "pure" laboratory study may use arbitrary stimuli and the complexity of the world of practice may be reduced for analysis, but the laboratory and practical setting are not different in kind. Errorless learning is the same phenomenon whether seen in reading or in arbitrarily chosen laboratory material. In the experimental analysis of behavior the "applied vs. pure" research distinction disappears. A thorough-going experimental analysis of reading instruction could improve our understanding of reading and solve many of the problems of reading instruction.

Figure Captions

Figure 1. Size and Luminance of S^+, S^- and Probe Stimuli.

Figure 2. Performance of five subjects given four size discrimination problems in the Sequence CCCC. Each problem had a 50-trial programmed series, a 10-trial criterion, and 5 probe sets. For the programmed series and the criterion, each trial moves the data line one step to the right, each errorful trial also moves the line one step upward. Performance on probe sets is coded as n, b, s, d. The probe key identifies the probe responding and the indicated stimulus control for each code letter.

Figure 3. Performance of five subjects given four size discrimination problems in the Sequence ABCC. Each problem had a 50-trial programmed series, a 10-trial criterion, and 5 probe sets. For the programmed series and the criterion, each trial moves the data line one step to the right, each errorful trial also moves the line one step upward. Performance on probe sets is coded as n, b, s, d. The probe key identifies the probe responding and the indicated stimulus control for each code letter.

Figure 4. Sir James Pitman's Initial Teaching Alphabet. Note. From the book Initial Teaching Alphabet by Sr. James Pitman. Copyright, 1973 by Pitman Publishing Corp. Reprinted by permission of Pitman Publishing Corp.

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OPEN DISCUSSION OF HOLLAND PRESENTATION

SHUY: I would like to call your attention to some research going on at Rockefeller University by Ray McDermott, who is doing studies of video tapes of reading classes. He has determined that one of the major distinctions between the good reading group and the poor reading group is the fact that the children in the good reading group are, unconsciously, telling the teacher who to call on next. In other words, they seem to be controlling the behavior of the teacher through their body movements.

STICHT: Jim, regarding, the ITA, I frequently found that the criticism was that even though initially it might have been a more rapidly effective decoding program, three or four years later it made no difference. Do those tests that come three or four years later focus more on comprehension than on decoding, and is there any reason to think that if it took one year to teach decoding by one program, and a half a year by the other, and if comprehension tests given three years later indicate that decoding has been learned under either one, would you still reject the faster decoding program?

HOLLAND: I am talking about the immediate effect.

STICHT: But I mean should we choose a decoding program because it is fast? How can decoding effect comprehension three years later, unless comprehension itself is somehow taught, too.

HOLLAND: Speaker requested that his comments be deleted.

STICHT: Sometimes I have seen write-ups about the ITA that say it's rejected because although it enables people to learn decoding faster, three years down the road there is no difference in the children.

But why would you expect there to be a difference in children, three years later, if they have, by then, all learned to decode? Why would anybody look for a difference then in a comprehension task?

HOLLAND: Speaker requested that his comments be deleted.

STICHT: I don't either.

HOLLAND: Speaker requested that his comments be deleted.

SAMUELS: In regard to the warning you shared with the group about using color coding as an aid to reading, I agree that the problem is one of transfer of stimulus control from the color to form and shape. The color is actually used as a prompt to elicit the response, and the student is supposed to focus attention on the visual characteristics of the word or letter. An experiment we did at Minnesota some years ago points out the problems. There was a very simple task. We gave college students a paired associate list to learn. The paired associate list had a high degree of visual stimulus similarity, and the subjects had to hook up words to the printed stimuli. One stimulus was printed in red, and all of the other stimuli were printed in black, but the shapes of the stimuli were similar. We told the students to ignore the color and to focus attention on shape. During the training phase, we always got the correct response to the stimulus in red, but, on transfer, we eliminated the color, and even though the subjects got repeated warnings and repeated trials, whenever the transfer phase

occurred and the color was eliminated, we got no response. It is obvious that the college students were unable to ignore the patent color cue and to attend to shape.

HOLLAND: They were worse off, really.

SAMUELS: Oh, yes, on the transfer task, they were worse off. It points up the problem with these programs that have color aids. The student keeps on looking at the irrelevant color dimension, and never focusses on the form, which is the relevant cue for the task of reading.

HOLLAND: I introduced Doran's study by talking about the selective attention literature. You are, correctly, carrying the analysis a step further than my paper did. Training on a single component of a compound stimulus will make acquisition more difficult for the other component. Extensive pretraining with an irrelevant cue retards learning the criterial task. Some fading sequences do just that. It's not simply that they do no good, they may actually do harm.

BATEMAN: Jay, on the same point, is it important to distinguish, in discussion of the use of color, the way it's commonly done from the way it's done in those few programs that merely use color as a cue to say the word?

SAMUELS: I think you have the same problem. If the student has a potent cue to use for the correct response, the principle of least effort operates; the student will use that cue which most easily elicits the correct response; in this case it's color. But in real reading, there are no colors. So at the transfer phase in real reading when the color cue is removed, you are worse off,

and I think that's the point that Tom was making.

Do you want to have rapid initial learning, but poor transfer, or would you rather trade that off for a little slower initial training, but good transfer?

STICHT: That's not exactly what I had in mind, but it's close. What I had in mind is this: Sometimes we hear a lot about differant ways of teaching decoding and different approaches. One of those was the ITA approach, for which you gave a nice theoretical rationale for why it ought to work. One criterion you might evaluate a program by is how rapidly it brings about the same effect that another approach will bring about. Now, the point I want to get to is that we have to have some criteria for selecting approaches. Rate, that is, how quickly it achieves it might be one of the deciding factors. But if we are going to wait until three or four years later, and then say, "Well, children who used ITA learned to decode faster than did the other children, but three or four years later the effects washed out," I want to know what washed out? Maybe using one kind of model, you could say that if you had given the person the ability to "unlock the key" to that spoken language, that if they couldn't speak too well or comprehend spoken language too well, haven't gotten the "key" real fast, wouldn't make any difference three years later, if they still didn't build and drill heavily on that. You end up with a normal distribution again three years later.

HOLLAND: Speaker requested that his comments be deleted.

SINGER: I get the impression when you are talking about this other paper that you tend to favor this natural contingency. Could you give us an idea of what that paper would be like?

HOLLAND: Speaker requested that his comments be deleted.

GOODMAN: I am interested in your relating either your task or your methodology to some theory of language development, for instance, Skinner's verbal learning theory.

HOLLAND: That's a large order for a brief discussion.

GOODMAN: Can I rephrase it then? Is there anything special about language or verbal learning that makes the kinds of things you have been talking about more or less appropriate, or is that just like all other kinds of learning.

HOLLAND: Language behavior has the same basis as other behaviors including reading. Verbal behavior is set apart only in that it involves a reinforcing community.

POSNER: This evaluation of ITA is a good place for analyses. Coding is really quite important, because if you look for the visual to phonetic decoding, ITA looks like a good thing to do, but if you place stress on the orthography, particularly as Massaro and Venezky did, and particularly if you think that getting a good orthographic chunk depends, in part, on visual familiarity, then maybe it is really a quite disastrous thing to do, even for the purpose of decoding.

HOLLAND: Good point.

CHALL: I think at the present time the data show that ITA has more problems for

spelling than for reading.

BATEMAN: Would you clarify or specify the objective which you think Bloomfield-Barnhart is a good way to get to?

HOLLAND: Getting kids to have the right kind of word attack.

BATEMAN: Speaker requested that her comments be deleted.

HOLLAND: Okay. When the child is through Bloomfield and Barnhart, the child can read just about any word that he can understand.

BATEMAN: In your paper do you have any citations to data for that?

HOLLAND: I base this on having used the material to teach two children to read. The effectiveness data I cite in the paper are from Sheldon, Ichols, and Lashinger. (But note the qualification I made regarding the difficulty in getting children to induce sound values.)

BATEMAN: Would you modify the methodology? I realize the materials are well programmed, but did you do what the little front part says to do?

HOLLAND: More or less. The front part seems to talk as if you have to move much slower than I think is desirable. It seemed to me going fast is the important thing.

RESNICK: In my memory of Bloomfield-Barnhart, all of the concerns that Beck and

Block raised last night about the Palo Alto sequence would hold: it would interfere with the skills of scanning ahead to figure out what the graphemic context was, and also it would probably provide relatively little natural reinforcement for a long time.

HOLLAND: Speaker requested that his comments be deleted.

RESNICK: And the talking typewriter?

HOLLAND: Speaker requested that his comments be deleted.

SAMUELS: This morning Barbara Bateman was talking about the importance of having the teacher point out the relevant dimensions of, let's say, letters. How are b, d, p and q different? They are visually similar, but you have to see them in relation to each other. Gibson points out that distinctive features are always relational and have to be seen that way.

Now, earlier you said that Skinner would recommend that when you teach a child to recognize letters, you might want to have an errorless discrimination pattern. Well, that would almost point to the opposite set of letters.

For example, if you never wanted a child to confuse b with another letter, you would put b and X next to one another. It would be very easy to discriminate one from the other.

How would you devise a program which would teach a child what the distinctive features of letters such as b, d, p and q, lower case, or lower case h, u, y and n? They have similar features; they are related to one another. How would you devise a program that would teach distinctive features, so that the

child could rapidly identify one letter and not mix it up with another?

HOLLAND: It happens that I have collaborated with Sid Bijou many years ago on a teaching machine program which established just such a skill. We weren't working on letters of the alphabet at all. Rather we were attempting to establish a basic aptitude (we might call them "new aptitudes" at LRDC today). We were teaching the space factor--one of Thurstone's primary mental abilities. We used a gradual progression that started very close to your B-X. The children matched forms, at first with very dissimilar forms, and later with a sample and five matching stimuli with four of them reflections of mirror images of the sample, and another one, the correct alternative, was simply a rotation of the sample. The problem was for the child to find the rotated sample and reject the mirror images. It's a difficult task, but with a proper progression they were able to do it. Then, as a tour de force, we used a transfer test, in which we used letter forms such as d, b, p, and so forth. The transfer was very good.

It did involve an errorless progression that went from easy to difficult.

SAMUELS: Would you want to train on nonsense figures or directly on the letters of the alphabet?

HOLLAND: If we had been primarily interested in the alphabet, we would have been trained on the alphabet; but we weren't.

GLASER: I am not sure the message, Jim, that you want us to take home, about whether or not fading, or transfer of stimulus control through fading, is recommended in the design of instruction in reading or not.

HOLLAND: Avoid fading on an irrelevant dimension even at high cost. If it can't be avoided, use the irrelevant dimension early, get rid of it as fast as possible, and make the target dimension as prominent as possible early in training.

PERFETTI: Speaker requested that his comments be deleted.

HOLLAND: I wouldn't think so. That's very much a part of reading, you wouldn't want to avoid it.

PERFETTI: To take it a step further, is there any point in the development of reading that you want to worry about?

HOLLAND: Speaker requested that his comments be deleted.

PERFETTI: No, no, I will try again. There is one analysis of reading which is under the control of something other than form; it is analogous to your analysis of poorly engineered programs. That is to say, that in some sense those stimulus factors--if we want to call them that--are not going to transfer necessarily to the kinds of stimulus controls that most people have in mind when they say someone can decode. Now, I only wanted to get you to say whether you thought there was some point at which it made sense not to worry about that; whether in general you could tell, in looking at a child's reading behavior when he was using miscues in your sense, as compared to the sense in which he is really doing something useful and meaningful in the reading situation.

HOLLAND: If I understand, you are asking whether a child, who because of

context, says "up" instead of "down," is using miscues.

PERFETTI: Let's take a definite article example that comes out. That's one extreme. Suppose he says, "Jimmy caught the bus," instead of "caught a bus." That is something most of us would think probably is not worth correcting, since he is on the right track. There are other kinds of miscues which would be farther off. My problem is seeing a stimulus control analysis mapping onto that type of behavior observation and thinking about what use to make of it.

HOLLAND: If you viewed reading as being totally and exclusively decoding, I guess you might worry about that, but I don't know anybody that believes that.

PERFETTI: No, the examples get more interesting. The example is, "He caught the bus," instead of "caught the train." Some people would say that is not so far off.

HOLLAND: Again, if your focus is entirely on decoding, I think you would correct him.

PERFETTI: But that is not a decoding emphasis, Jim. That is an emphasis on meaning. There is a difference in meaning between "He caught the bus" and "He caught the train." They just happen to have comparable messages in some context.

RESNICK: Is your question: Should we always be seeking errorless learning, or close to errorless learning, or are there times when the errors are functional? Or am I oversimplifying?

PERFETTI: No, it is much simpler. It is just a question of trying to decide when, if you are going to use stimulus control language, you talk about behaviors connected with the print on the page, some reading behaviors are going to look pretty far off base, they are attached to the wrong stimulus conditions. The fading problems that you have pointed to have, perhaps, been built into the instructional program too severely. I am simply asking whether you have any further insights into this problem that exist in so many other forms. How do you know when to worry about it and when not to worry about it?

HOLLAND: The problem is in the specification of the target behavior. I don't think everybody's definition of reading would include worrying about contextual misreadings of occasional sorts, but I suspect that such overconcern would result in a poor quality of reading--slower and more ponderous reading.

PERFETTI: Presumably that's part of the answer. I mean, the history of the overall reading behavior is a clue.

END SESSION